JOURNAL OF VETERINARY AND APPLIED SCIENCES
VOLUME 16, ISSUE 1: 1300 – 1309 (2026)
Published by: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria
ISSN: 2315-6856; e-ISSN: 2636-5553; Website: www.jvasonline.com

The use of human urine test strips (HUTS) for urinalysis in animals: comparison of urine glucose levels of horses as determined using HUTS and a biochemical analyzer

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Abstract

Urinalysis is a very useful low-cost diagnostic tool in both human and veterinary medical practice. Human urine test strips (dipsticks) are commonly used for urinalysis in veterinary practice, and the accuracy and reliability of these test strips for the urinalysis in specific animals have not been fully investigated. The present study compared horse urine glucose test results obtained using Medi-Test Combi 9® (MTC9) test strips with results obtained using a Diatek® semi-automated biochemistry analyzer (DSBA). Urine samples used for the study were obtained from 342 horses, by cystocentesis, at point of slaughter at the Obollo-Afor Horse Abattoir, Enugu State Nigeria. Glucose estimation using the MTC9 test strips was done within one hour of urine sample collection. Urine glucose quantification using the DSBA was done following the glucose oxidase method using Dialab® glucose test kit with calibration standards. Results showed that there was no significant difference ($p > 0.05$) between the means of urine glucose levels of the 342 horses as determined using the DSBA (65.03 ± 13.11 mg/dl) when compared with estimates obtained using MTC9 test strip (63.88 ± 16.17 mg/dl). There was a moderate and significant positive correlation ($r = 0.473$; $p < 0.01$) between the urine glucose levels of the 342 horses determined by the two procedures. Urine glucose levels of more than 80% (MTC9) and 90% (DSBA) of the horses were between 51 – 90 mg/dl, which was above the levels considered normal in humans (≥ 50 mg/dl). An area chart of the urine levels of the apparently healthy horses as determined by the DSBA showed that urine levels between 50 and 90 mg/dl lie within the normal range. Though there was no significant difference between the means of the urine glucose as determined by MTC9 and DBSA, the correlation between the two procedures was only moderately positive; implying that MTC9 tests strips may not give reliable results of urine glucose levels for horse urine. Also, the normal/reference urine glucose levels of the horses evaluated (50 – 90 mg/dl) was relatively higher than the 30 – 50 mg/dl that is considered normal in humans.

Keywords: Urinalysis; Urine Glucose; Human urine test strips (dipstick); Horses; Biochemical analyzer.

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Article History: Initial manuscript submission received – November 07, 2025; Final revised form received – February 06, 2026; Accepted for publication – February 14, 2026; Published – February 18, 2026.

Introduction

Urinalysis is a low cost non-invasive and invaluable diagnostic screening tool used in both human and veterinary medical practice (Simerville *et al.*, 2005; Parrah *et al.*, 2013). It involves physical, chemical and microscopic examination of urine (Simerville *et al.*, 2005; Echeverry *et al.*, 2010; Parrah *et al.*, 2013; Yadav *et al.*, 2020). Urinalysis can reveal many diseases that do not manifest striking signs and symptoms, and which may thus go unnoticed, such as diabetes mellitus, urinary tract infections, malignancies and kidney dysfunction (Parrah *et al.*, 2013; Yadav *et al.*, 2020).

In both human and veterinary clinics and hospitals, chemical urinalysis is commonly done using point-of-care urine test strips (also known as dipsticks) that offer qualitative and semi-quantitative information of the presence and/or levels of substances such as glucose, proteins, blood, bilirubin, etc., and which enables faster clinical decisions at lower administrative and procedural costs (Larkins *et al*., 2025; Jumah *et al*., 2025). The general accuracy and reliability of urine dipsticks in detecting specific diseases and quantifying specific substances in urine has been amply reported (Zamanzad, 2009; White *et al.*, 2011; Mambatta *et al*., 2015; Mills *et al.*, 2025; Kristensen *et al.*, 2025).

The use of human urine test strips (HUTS) for evaluating the urine of animals is very rife in veterinary practice because HUTS are readily available and also affordable. As the HUTS were not designed for animals, some of the readings obtained with them may be inaccurate and unreliable due to concentration differences and other species-specific limitations (Paquignon *et al.*, 1993; Pressler *et al.*, 2002; Aulbach *et al.*, 2015; Hekmatynia *et al.*, 2019; Abebayehu, 2023). The accuracy and reliability of human urine test strips have been reported to vary depending on which specific substances are being tested (proteins, glucose, blood, bilirubin, etc.) and also which species of animal it is being applied to (Paquignon *et al.*, 1993; Pressler *et al.*, 2002; Hekmatynia *et al.*, 2019).

For horse urine specifically, reports by Hekmatynia *et al.,* (2019) showed that commercially available HUTS were not reliable for the estimation of urine protein, specific gravity and pH. There are however no reports in available literature on how accurate and reliable human urine test strips are for the measurement of urine glucose levels in horses.

The presence of detectable levels of glucose in urine is known as glucosuria (Liman and Jailal, 2023). Serum glucose is reported to be freely filtered by the glomerulus and subsequently reabsorbed from the ultrafiltrate by the proximal tubules, and the reabsorption of glucose by the renal tubules is a saturable process, such that serum glucose levels beyond a threshold (> 150 – 180 mg/dl depending on the species) will result in more glucose in the ultrafiltrate than can be reabsorbed by the renal tubules (Chapman *et al*, 1981; Liman and Jailal, 2023; Brown *et al.*, 2025).

In horses, just as in other animals, glucosuria has been reported to be associated with hyperglycemia and/or defective renal tubular resorption of glucose as a result of renal tubular abnormalities or damage (Chapman *et al.*, 1981; Cohen and Carter, 1992; Constable *et al.*, 2017; Brown *et al.*, 2025). With the dearth of available information on the accuracy and reliability of using human urine test strips for measurement of urine glucose levels in horses, the present study compared results of horse urine glucose levels obtained using human urine test strips with those obtained using a semi-automated biochemistry analyzer.

Materials and Methods

This study was an offshoot of a cross-sectional chemical urinalysis survey of horses at the Obollo-Afor lairage, Enugu state, Nigeria (Ihedioha *et al*., 2025). In the above referenced study, urine samples were obtained from 342 horses, between February and May 2024, by cystocentesis at point of slaughter at the horse abattoir. The use of the horses and their urine for the study was approved by the Animal Care and Use Committee of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka (Approval Reference Number: FVM-UNN-IACUC-2024-06/160).

Before collection of the urine samples, the horses were physically examined at the lairage, numbered serially and categorized into apparently healthy or unhealthy, female or male and adult or young, following the methods described by Ugochukwu (2001).

The glucose levels in the urine samples were first estimated using the Medi-Test Combi 9® (MTC9) test strips (Macherey Nagel GmBH & Co., Duren, Germany), within one hour of urine sample collection to avoid degeneration and artifactual changes (Veljkovic *et al*., 2012; Parikh *et al*., 2025). The detection of glucose in urine using the MTC9 test strips was based on the glucose oxidase-peroxidase-chromogen reaction, and glucose concentrations were indicated by a colour change from green to bluish green. Following the manufacturer's specifications, the colour band ranged semi-quantitatively from yellow (lowest) (< 30mg/dl), through greenish (30 – 50 mg/dl) to deep bluish green (range from 50, 150, 500 to 1000 mg/dl). For the MTC9 testing, using a 5 ml syringe, the urine samples were individually dropped on the glucose band of each urine test strip (rather than dipping it into the urine), and was allowed to stand for one second, before being thrown off, after which the colour change was read after thirty seconds by matching with the colour panel provided by the manufacturer which is graduated from 0 - ≥ 1000 mg/dl. The results obtained using the MTC9 test strip were recorded for each horse's urine.

After the estimation using the MTC9 test strips, the urine samples were centrifuged at 3,000 revolutions per minute for five minutes and the supernatant was collected and stored in a laboratory freezer. At the end of the sample collection, the glucose level of all the frozen urine samples was assayed using a Diatek® Semi-automated Biochemistry Analyzer (DSBA) [Wuxi Hiwell Diatek Instruments Co. Ltd., Wuxi, China]. A Dialab® glucose test kit (Dialab, Neudorf, Austria) based on the glucose oxidase method (Barham and Trinder, 1972; Lott and Turner, 1975; Kumar and Gill, 2018) was used for the biochemical analysis. Briefly, 10 µl of the urine sample was mixed with 1000 µl of the Dialab® glucose reagent in a clean test tube, this was allowed to stand at room temperature (20 - 25°c) for 20 minutes. The absorbance of the mixture was read at 546nm wavelength against that of the glucose reagent blank and compared with that of a standard containing 100 mg/dl of glucose. The results were printed out afterwards.

Data Analysis and Presentations: Data generated from both the estimation using MTC9 strips and the semi-automated biochemistry analyzer were subjected to descriptive statistics; they were further compared and correlated using SPSS for Windows software. Significance was accepted at $p < 0.05$. Summary of the results were presented as means ± standard deviation (SD), tables and shaded normal curve.

Results

The 342 urine samples used for the study were obtained from 267 apparently healthy horses and 75 horses that were categorized as unhealthy. The sex distribution of the horses was: 219 females and 123 males; while the

age distribution was: 195 adults and 147 young.

The mean ± standard deviation (SD) urine glucose levels of the 342 horses used for the study as determined using the DSBA was 65.03 ± 13.11 mg/dl, while the mean ± SD of the horse urine glucose levels as estimated using MTC9 test strip was 63.88 ± 16.17 mg/dl, and there was no significant difference ($p > 0.05$) between the means [Figure 1]. There was a moderate and significant positive correlation ($r = 0.473$; $p < 0.01$) between the urine glucose levels of the 342 horses as determined by the two procedures.

When the urine glucose levels were segregated based on the health status of the horses, the mean urine glucose of the 267 apparently healthy horses as determined using DSBA (64.63 ± 13.65 mg/dl) did not significantly differ ($p > 0.05$) from the results obtained using the MTC9 test strips (63.25 ± 16.30 mg/dl) [Figure 1], and the correlation between the two were also moderate, positive and significant ($r = 0.461$; $p < 0.01$). For the unhealthy horses, the mean urine glucose of the 75 unhealthy horses as determined using DSBA (66.41 ± 10.90 mg/dl) did not significantly ($p > 0.05$) differ from that estimated using the MTC9 procedure (66.25 ± 15.51 mg/dl) [Figure 1], and the correlation between the two procedures was also moderate, positive and significant ($r = 0.517$; $p < 0.01$).

It was noted that the urine glucose levels of more than 80% of the horses were above the levels considered normal in humans (≥ 50 mg/dl) and that with both DSBA and MTC9 procedures, the urine glucose levels of most of the horses were between 51 – 90 mg/dl (Table 1). An area chart of the urine levels of the apparently healthy horses as determined by the DSBA showed that urine levels between 50 and 90 mg/dl lie within the normal range (Figure 2).

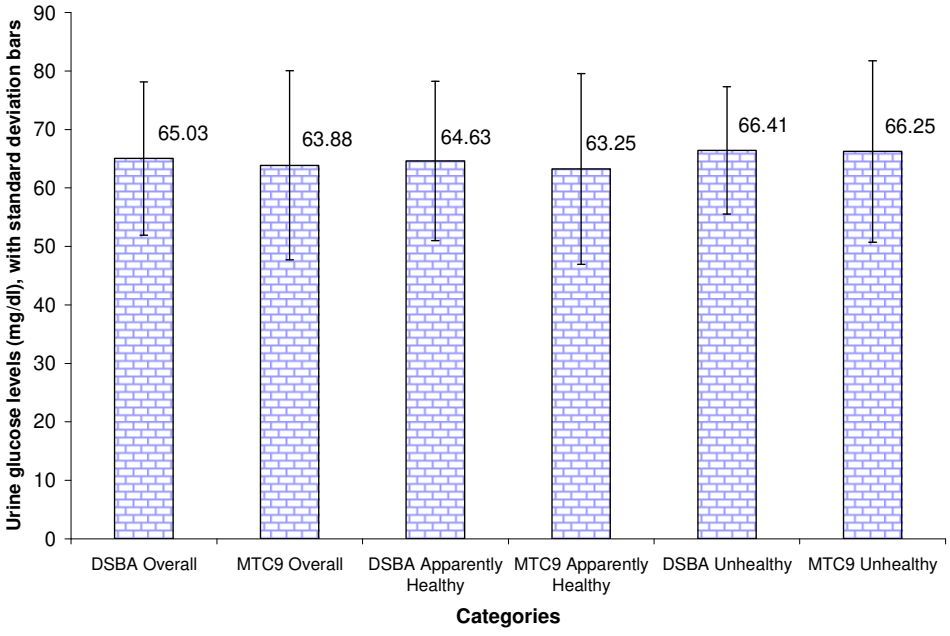

Figure 1. Comparison of the mean horse urine glucose levels measured using a Diatek® Semi-automated Biochemistry Analyzer (DSBA) and Medi Test Combi 9 (MTC9) urine test strips (dipsticks).

Table 1. Comparative distribution of urine glucose levels of apparently healthy horses measured using a Diatek® Semi-automated Biochemistry Analyzer (DSBA) and Medi Test Combi 9 (MTC9) urine test strips (dipsticks).

Urine glucose levels (mg/dl)	Number of horses urine samples with glucose levels within the specified range, with % in bracket, as determined by the two procedures.	
	DSBA	MTC9
0 – 10	4 (1.5%)	2 (0.8%)
11 – 20	6 (2.2%)	7 (2.6%)
21 – 30	0 (0%)	2 (0.8%)
31 – 40	2 (0.8%)	12 (4.5%)
41 – 50	10 (3.7%	27 (10.1%)
51 – 60	41 (15.4%)	81 (30.3%)
61 – 70	118 (44.2%)	50 (18.7%)
71 – 80	76 (28.5%)	65 (24.3%)
81 – 90	10 (3.7%)	19 (7.1%)
91 – 100	0 (0%)	2 (0.8%)
101 – 110	0 (0%)	0 (0%)
Total	**267 (100%)**	**267 (100%)**

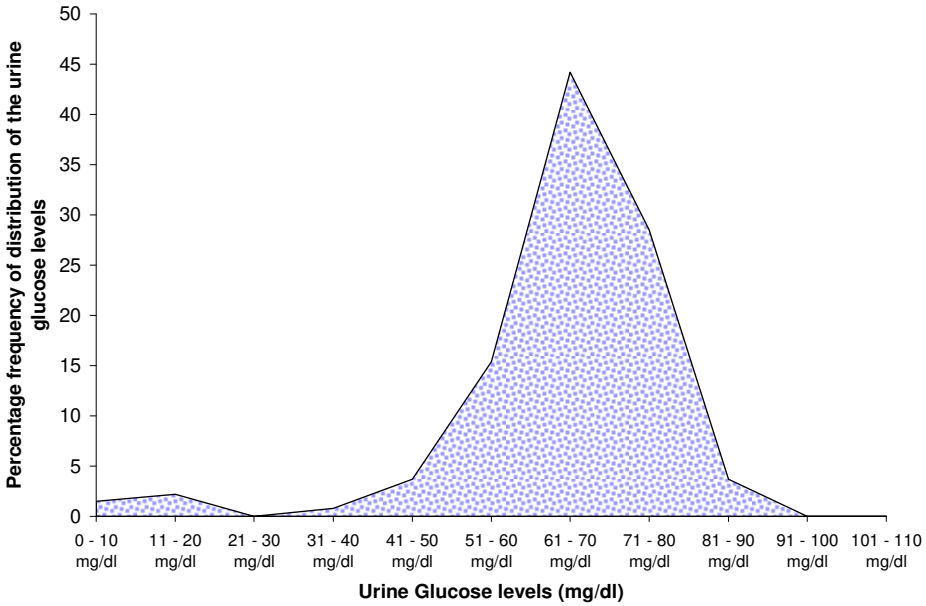

Figure 2. Distribution of urine glucose levels of apparently healthy horses as measured using a Diatek® Semi-automated Biochemistry Analyzer.

Discussion

The finding in the present study that the means of the horse urine glucose levels as determined by the two procedures (DSBA and MTC9) were very close to each other and did not significantly differ is believed to be due to the fact that both the DSBA determination and the MTC9 estimation were based on the glucose oxidase method (Lott and Turner, 1975; Raba and Mottola, 1995; Yuen and McNeill, 2000; Kumar and Gill, 2018), which is well known for its precision, stability, practicability in the laboratory, and specificity for glucose, uninfluenced by interfering substances (Passey *et al*., 1977; Sheiko *et al*., 1979; Giapietro *et al*., 1982).

The moderate positive and significant correlation found between results of the DSBA and MTC9 procedures in the present study implies reasonable disparity between the two results, even when their means were close, and brings to the fore some of the reported weaknesses and disadvantages of the mean as a measure of the central tendency (Gonzales and Ottenbacher, 2001; Manikandan, 2011; Khorana *et al.*, 2023). Further, the moderate correlation recorded in the present study (r = 0.473) between the horse urine glucose values determined by the DSBA and that estimated using MTC9 test strips concurs with earlier reports of weak to moderate correlation between horse urine levels of protein (r = 0.485 – 0.534), pH (r = 0.370 – 0.445) and specific gravity (r = 0.285 – 0.338) estimated using human urine dip sticks and the results obtained by reference method (Hekmatynia *et al*., 2019). Our present finding of only a moderate correlation however contrasts with reports of the use of human urine test strips on human urine (Pighi *et al*., 2023) in which a high positive correlation was found (r = 0.83) between dipstick results and reference Roche COBAS 8000 procedure. Our present finding in horse urine also contrasts with the reports of Zamanazad (2009) which showed that human urine dip sticks used for human urinalysis had high sensitivity (100%), specificity (98.5%), positive predictive value (87%) and negative predictive value (100%). All these taken together, suggests that while human urine tests strips may be good enough for human urine, it does not offer reliable results for horse urine glucose.

The further finding that there were no significant differences between the mean urine glucose levels of the apparently healthy horses when compared to the unhealthy, implies that the level of the urine glucose was not significantly associated with the state of health of the horses. Also, the finding that none of the horses surveyed had extreme high urine glucose levels (> 100 mg/dl) concurs with the earlier reports that conditions such as diabetes mellitus is rare in horses (Durham *et al.*, 2009; Akinniyi *et al*., 2024) and that horse kidneys are known for their efficiency in glucose reabsorption (Poiree *et al*., 1978).

A very high proportion (more than 80%) of urine glucose levels recorded in the present study were more than the levels (> 50 mg/dl) considered normal in humans. This is a very important point to note when using human urine test strips for urinalysis in veterinary practice because the concentrations of the substances being estimated/determined may significantly vary between humans and animals, and cut-off values and thresholds set up for human urine may not apply to some species of animals. The result of the present study suggests and implies that urine glucose levels below ≤ 90 mg/dl should be considered normal in horses, as earlier reported by Ihedioha *et al*. (2025). It is thought that the relatively higher normal/reference glucose levels in horses relative to humans may be related to the earlier reported higher resting blood glucose levels of horses (70 – 135 mg/dl) relative to humans (70 – 108 mg/dl) (Hollis *et al.,*2007; Hassel *et al.,* 2009; Guemes *et al.,* 2016; Mathew *et al.,* 2023; Velineni *et al.,* 2024), even when both horse and human kidneys are reportedly renown for being

efficient in glucose reabsorption (Poiree *et al*., 1978; Cowart and Stachura, 1990; Silverman and Turner, 1991; Vallon and Nagakwa, 2021).

Conclusion: Based on the results of the present study, it was concluded that the correlation between results of horse glucose urine levels obtained using MTC9 human urine test strips and that obtained using DSBA is only moderately positive, which implies that estimation of horse urine glucose levels using MTC9 test strips may not be accurate and reliable. Also, normal horse urine glucose levels may be higher (50 – 90 mg/dl) than the values considered normal in humans (< 50 mg/dl).

Conflict of Interest

The authors declare no conflict of interest

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